PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-249363
(43)Date of publication of application : 14.09.2001

(51)Int.Cl. G02F 1/137
G02F 1/1337

(21)Application number : 2000-060553
(22)Date of filing : 06.03.2000

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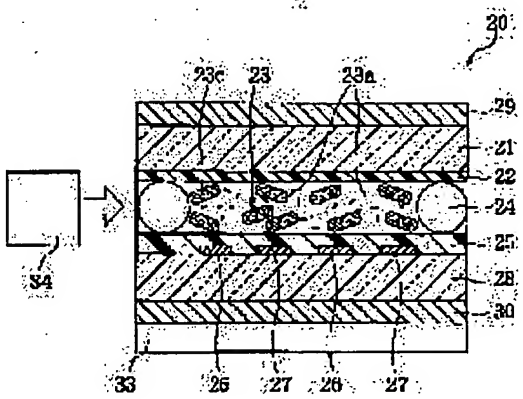
(54) DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a display device of high response speed, which is suitable for moving image display and capable of being driven at low voltage.
SOLUTION: In the display device 20, a glass substrate 21, having a polyimide film 22 formed on the surface thereof and a glass substrate 28 having a pixel electrode 26 and a counter electrode 27, which form a teeth-shaped electrode and a polyimide film 25 formed on the surface thereof are stuck to each other via glass fiber spacers 24 to form a gas specified to have 50 μm gap length and a medium containing polar molecules 23a made into an isotropic phase state by a heater 34, which is a phase-changing means, is shield from between the glass substrates 21 to 28.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The display characterized by having the medium containing the polar molecule of a direction phase state — at least one side was pinched between the substrate of a transparent pair, and the substrate of said pair — the polarizing plate arranged in one [at least] outside among the substrates of said pair, and an electric-field impression means for impressing electric field to said medium.
[Claim 2] The display characterized by having the medium containing the polar molecule with which at least one side was pinched between the substrate of a transparent pair, and the substrate of said pair, the polarizing plate arranged in one [at least] outside among the substrates of said pair, a phase transition means for making said medium into an isotropic phase condition, and an electric-field impression means for impressing electric field to said medium.
[Claim 3] Said electric-field impression means is a display according to claim 1 or 2 which is the Kushigata electrode of the pair formed in the medial surface of one [said] substrate, and is characterized by the direction of electric-field impression being parallel to a substrate side.
[Claim 4] Said electric-field impression means is a display according to claim 1 or 2 which is the electrode formed in each medial surface of the substrate of said pair, and is characterized by the direction of electric-field impression being perpendicular to a substrate side.
[Claim 5] Said Kushigata electrode is a display according to claim 3 characterized by being the character type configuration of plane view "**."
[Claim 6] The polar molecule in said medium is a display according to claim 1 to 5 characterized by forming the cluster.
[Claim 7] It is the display according to claim 1 to 6 which the dielectric thin film is formed in the medial surface of said substrate, and is characterized by making orientation processing predetermined in this dielectric thin film.
[Claim 8] Said dielectric thin film is a display according to claim 7 characterized by being an organic thin film.
[Claim 9] Said organic thin film is a display according to claim 8 characterized by being polyimide.
[Claim 10] Said polar molecule is a display according to claim 2 to 9 characterized by including a liquid crystal ingredient.
[Claim 11] Said polar molecule is a display according to claim 2 to 9 characterized by including a liquid crystal ingredient and the ingredient into which the isotropic phase transition temperature of this liquid crystal ingredient is reduced.
[Claim 12] The ingredient into which the isotropic phase transition temperature of said liquid crystal ingredient is reduced is a display according to claim 11 characterized by being the ingredient which has a cyano group, a hydroxyl group, or a nitro group at the molecule end.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the display which has the display engine performance of the wide field of view by the high-speed response which displays a television picture, and a personal computer and a multimedia image.
[0002]
[Description of the Prior Art] The commercial scene of various high definition panel displays is expanded quickly in recent years, and among these, since the liquid crystal display component is effective in small, a light weight, a thin shape, and low electrification, it is widely used for OA equipment, such as image display devices, such as television and video, and a monitor, a word processor, a personal computer.
[0003] Although the liquid crystal display component in the Twisted Nematic (TN) mode using the pneumatic liquid crystal forward in a dielectric constant anisotropy as a liquid crystal display component is put in practical use conventionally, for example, a speed of response is slow and the liquid crystal display component in said TN mode has a fault, like an angle of visibility is narrow.
[0004] Moreover, although a response is quick and display modes, such as a ferroelectric liquid crystal (FLC) with a large angle of visibility and antiferroelectricity liquid crystal (AFLC), also have it, shock-proof nature, the temperature characteristic, etc. have a big fault, and by the time it is put in practical use widely, it will not have resulted.
[0005] Moreover, although the polymer dispersed liquid crystal display mode using light scattering does not need a polarizing plate but a daylight display is possible, in being unable to perform viewing-angle control by the phase plate in essence, it has the technical problem in the response characteristic, and there is few predominance over TN mode.
[0006]
[Problem(s) to be Solved by the Invention] Although the case where a movie display is treated increasingly will increase from now on, there is still no display which has sufficient response characteristic. The purpose of this invention offers the display with which the speed of response was quickly suitable for the cine mode display.
[0007]

[Means for Solving the Problem] In order to solve said technical problem, invention according to claim 1 The medium containing the polar molecule of a direction phase state — are a display and at least one side was pinched between the substrate of a transparent pair, and the substrate of said pair — It is characterized by having the polarizing plate arranged in one [at least] outside among the substrates of said pair, and an electric-field impression means for impressing electric field to said medium.

[0008] The display of said configuration is the configuration which gives a refractive-index anisotropy to a medium by impressing electric field to said medium with an electric-field impression means, and biasing the electron in the polar molecule of an isotropic phase condition in the direction of electric field. Such a display uses the so-called Kerr effect proportional to the 2nd order of electric field, shows the response characteristic for several microseconds - several ms, and becomes a high-speed response is possible and possible [applying also to a movie display]. Thus, the display of this invention does not display by change of the array of a liquid crystal molecule like the conventional liquid crystal display, and displays by change of the spin polarization of electron, and a high-speed response is possible for it.

[0009] Invention according to claim 2 is a display. Moreover, the substrate of a pair at least with transparent one side, It is characterized by having the medium containing the polar molecule pinched between the substrates of said pair, the polarizing plate arranged in one [at least] outside among the substrates of said pair, a phase transition means for making said medium into an isotropic phase condition, and an electric-field impression means for impressing electric field to said medium.

[0010] The display of said configuration is equipped with the phase transition means for making a polar molecule into an isotropic phase condition, and can make said medium an isotropic phase condition with the phase transition means concerned. Therefore, the display according to claim 2 can also be used as the display applied to the animation display as which the Kerr effect is used and a high-speed response is required like a display according to claim 1.

[0011] Moreover, invention according to claim 3 is a display according to claim 1 or 2, and said electric-field impression means is the Kushigata electrode of the pair formed in the medial surface of one [said] substrate, and is characterized by the direction of electric-field impression being parallel to a substrate side.

[0012] Moreover, invention according to claim 4 is a display according to claim 1 or 2, and said electric-field impression means is the electrode formed in each medial surface of the substrate of said pair, and is characterized by the direction of electric-field impression being perpendicular to a substrate side.

[0013] Like said configuration, even if it is the configuration of claim 3 and is the configuration of claim 4, the display in which a high-speed response is possible is realized.

[0014] Moreover, invention according to claim 5 is a display according to claim 3, and said Kushigata electrode is characterized by being the character type configuration of plane view "**."

[0015] Like said configuration, the angle-of-visibility property of a display improves by making a tandem-type electrode into the character type configuration of plane view "**."

[0016] Moreover, invention according to claim 6 is a display according to claim 1 to 5, and it is characterized by the polar molecule in said medium forming the cluster.

[0017] The above "a cluster" means the molecule ensemble whom the polar molecule forms in said medium, and although said polar molecule is in an isotropic phase condition macroscopically, the molecule ensemble who arranged in a certain direction microscopically is formed. And by forming said cluster, the Kerr constant of a medium can be increased and it becomes possible to reduce the applied voltage impressed to a medium according to increase of a Kerr constant.

[0018] Moreover, invention according to claim 7 is a display according to claim 1 to 6, the dielectric thin film is formed in the medial surface of said substrate, and this dielectric thin film is characterized by making predetermined orientation processing.

[0019] While forming a dielectric thin film in the medial surface of the substrate which constitutes a display like said configuration, by carrying out orientation processing of this dielectric thin film, whenever [order / of orientation] can be made to raise and a big Kerr constant is expected. Moreover, in invention according to claim 6, a Kerr constant can be increased, if it becomes possible to increase the path of the cluster which is a molecule ensemble and the path of a cluster increases. Therefore, reduction (for example, a drive by the low battery not more than 100V should be attained, and present practical use) of the further applied voltage is attained.

[0020] Moreover, invention according to claim 8 is a display according to claim 7, and it is characterized by said dielectric thin film being an organic thin film.

[0021] Moreover, invention according to claim 9 is a display according to claim 8, and it is characterized by said organic thin film being polyimide.

[0022] Since the orientation effect in which said polyimide was extremely excellent an organic thin film and by considering as polyimide especially in said dielectric thin film is shown like said configuration, it becomes possible to increase a Kerr constant easily. Moreover, said polyimide is an extremely stable ingredient and is reliable. Therefore, the display in which the good display engine performance is shown can be offered by using said polyimide.

[0023] Moreover, invention according to claim 10 is a display according to claim 2 to 9, and it is characterized by said polar molecule containing a liquid crystal ingredient.

[0024] Moreover, invention according to claim 11 is a display according to claim 2 to 9, and said polar molecule is characterized by including a liquid crystal ingredient and the ingredient into which the isotropic phase transition temperature of this liquid crystal ingredient is reduced.

[0025] When a liquid crystal ingredient is used as a polar molecule by considering as said configuration, the liquid crystal ingredient concerned is applied to a display as an isotropic phase condition with heating of the heater which is a phase transition means. In that case, although a liquid crystal ingredient will be in an isotropic phase condition more so that whenever [at a heater / stoving temperature] is high, a Kerr constant will fall. And since the fall of a Kerr constant increases applied voltage, its convenience on real use is bad.

[0026] However, the isotropic phase transition temperature of a liquid crystal ingredient can be reduced, without reducing a Kerr constant by adding the ingredient which reduces the isotropic phase phase transition temperature of this liquid crystal ingredient into said liquid crystal ingredient. Therefore, since a Kerr constant does not fall, a display can be driven by the low battery, without applied voltage increasing. Moreover, whenever [at a heater etc. / stoving temperature] can be reduced and the operating temperature limits of a display can be made large.

[0027] Moreover, invention according to claim 12 is a display according to claim 11, and the ingredient into which the isotropic phase

transition temperature of said liquid crystal ingredient is reduced is characterized by being the ingredient which has a cyano group, a hydroxyl group, or a nitro group at the molecule end.
[0028] By adding the ingredient which reduces the isotropic phase phase transition temperature of this liquid crystal ingredient into said liquid crystal ingredient, for example, the non-liquid crystal molecule which has a cyano group, a hydroxyl group, or a nitro group at the molecule end, the phase transition temperature to the isotropic phase condition of a liquid crystal ingredient can be reduced, therefore the operating temperature limits of a display can be made large.
[0029]
[Embodiment of the Invention] Hereafter, it explains, referring to a drawing about the display in the gestalt of operation of this invention. However, a part unnecessary to explanation has the part which illustrated by carrying out expansion or contraction, in order to omit and to give explanation easy.
[0030] Here, before explaining concretely about the display of this invention, the principle of the electro-optical effect applied to this invention is explained using drawing 10 . Drawing 10 is the schematic diagram showing the system of measurement of the electro-optical effect of the gestalt of operation of this invention.
[0031] The electro-optical effect is the phenomenon in which the refractive index of the matter changes with external electric fields, and there are effectiveness proportional to the 1st order of electric field and effectiveness proportional to the 2nd order, and it is called the Pockels effect and the Kerr effect, respectively.
[0032] Among said electro-optical effects, application to a high-speed optical shutter is advanced early, and, as for the Kerr effect, the utilization to a special measuring machine machine is made especially. Moreover, since it is proportional to the 2nd order of electric field, when a low-battery drive can be expected relatively, since said Kerr effect shows the response characteristic for several microseconds - several ms, it can essentially expect the application to the display in which a high-speed response is possible.
[0033] The magnitude of this secondary electro-optical effect is called a Kerr constant.
[0034] Although a birefringence will be produced if electric field (E) are now added to the liquid crystal ingredient (it considers as the isotropic phase condition by heating a liquid crystal ingredient) made into the isotropic phase condition, when the refractive index of a direction perpendicular to n//and the direction of electric field is made into n** for the refractive index of the direction of electric field, the magnitude (deltan=n//-n**) of a birefringence and the relation of external electric field are delta n=BlambdaE 2. — (1)
It is come out and expressed.
[0035] B is a Kerr constant and lambda is the wavelength of the incident light in the inside of a vacuum here.
[0036] If the plane of polarization carries out incidence of the linearly polarized light which inclined in the direction of electric field 45 degrees to a cel as shown in drawing 10 , at the termination of a cel, phase contrast (gamma) like a degree type will arise between the polarization components of the direction of electric field, and a direction perpendicular to it.
gamma=2piLdelta n/lambda — (2)
[0037] Therefore, since the light which penetrated the cel turns into elliptically polarized light according to the aforementioned (2) formula, the part can pass an analyzer (polarizing plate) 9 now, serves as the linearly polarized light again, and carries out outgoing radiation. And the reinforcement I is expressed with a degree type.
I=I0sin2 (gamma/2) — (3)
[0038] Here, I0 expresses incident light reinforcement. From gamma= 0, if electric field are not added to a cel, although it is I= 0, when electric field are added and it becomes gamma=pi, it becomes I=I0 and 100% of optical intensity modulation can be performed. The electrical potential difference at this time is called half-wave voltage (Vpi). On the other hand, when the relation of E=V/d is used, it is gamma=2piBV2 (L/d2) from (1) and (2) types. — (4)
Since it is calculable, it can ask for half-wave voltage like a degree type as gamma=pi by this formula.
V pi=d / (2LB) 0.5 — (5)
[0039] That is, the Kerr constant B transforms (5) types and is as follows.
B=d2/2LVpi2 — (6)
[0040] In the following examples, electrical-potential-difference Vpi used as I=I0 was surveyed, and it asked for the Kerr constant B by count from (6) types.
[0041] In drawing 10 , a cel 6 receives supply of power from the modulation power source 7. 8 and 9 are polarizing plates (however, the following calls nine an analyzer.), and those polarization shafts are in the physical relationship which intersected perpendicularly mutually.
[0042] Moreover, with the electric-field impression direction of a cel 6, said polarizing plate 8 and analyzer 9 were leaned 45 degrees, and are arranged. When electric field do not join a cel 6, since an opto electronics material 1 is an isotropic phase, a beam of light 10 passes through the inside of a cel 6 without changing the polarization direction, and it considers it from arrangement of a polarizing plate 8 and an analyzer 9, and a beam of light 10 does not reach a detector 11.
[0043] If electric field join a cel 6, since form birefringence is shown and a difference arises in the refractive index of the electric-field impression direction and a direction perpendicular to it, the phases of the light spread in each direction will differ, and phase contrast will produce an opto electronics material 1. For this reason, generally the light which passed the cel 6 is elliptically polarized light. Therefore, some components can pass an analyzer 9 now and a beam of light comes to reach a detector 11.
[0044] When said phase contrast becomes pi radian (equivalent to the half-wave length), the light which passed the cel 6 changes to the linearly polarized light with the same polarization direction as an analyzer 9, and a beam of light 10 comes to reach a detector 11 about 100%. The electrical potential difference which joins the cel 6 at this time is called half-wave voltage (Vpi).
[0045] For example, when the 4-cyano-4'-n-pentyl biphenyl which is the liquid crystal ingredient shown in [1] (** 1) in Table 1 was enclosed, it was set as 33.3 degrees C (pneumatic-isotropic phase phase transition temperature), and a helium-Ne laser beam (633nm) was used for a cel 6 as a beam of light 10 become irregular, and the electrical potential difference was impressed to the cel 6, the output of a detector 11 reached the highest in 517V. It is shown that said optical phase contrast became pi radian, and, as for this value, it is equivalent to half-wave voltage (Vpi).
[0046] Since Kerr constant B is calculated as (6) types when the electrode spacing d in said cel 6 is set to 1mm and electrode die-length L of the beam-of-light passage direction is set to 10mm, Kerr constant B of this ingredient becomes 1.87x10-8 cm/V2. In addition, this means that 100% of intensity modulation can be performed on the electrical potential difference of 82V, when it is the Kushigata electrode spacing of d= 50 micrometers of a horizontal electric-field method, and the cel gap of L= 1mm. (In being the

Kushigata electrode spacing of d= 10 micrometers, and the cel gap of L= 50 micrometers, it can perform 100% of intensity modulation on the electrical potential difference of 73V.)

[0047] About various liquid crystal ingredients, the result of having measured Kerr constant B with the pneumatic-isotropic phase phase transition temperature is shown in Table 1.

[0048]

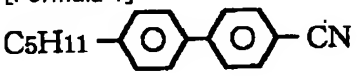
[Table 1]

		Vπ[V]	B×10^{-11} [cm/V^2]	温度[℃]
[1]	5CB	517(73)	187.0	33.3
[2]	5OCB	318(45)	494.2	66.9
[3]	3OCB 5OCB 7OCB (等量混合物)	282(40)	628.1	65.5
[4]	PCH5	470(66)	226.0	54.6
[5]	3HPFF (30wt.%) 5HPFF (40wt.%) 7HPFF (30wt.%)	350(49)	408.2	113.0

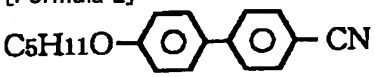
(Vπ:L=10㎜,d=1㎜、括弧内はL=50μm,d=10μm)

[0049] [1] in Table 1 — or — The chemical formula of the liquid crystal ingredient shown in [5] is shown in order below. [moreover,]

[Formula 1]



[Formula 2]



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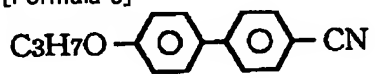

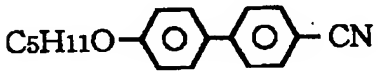

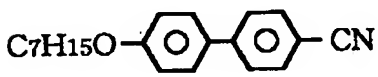

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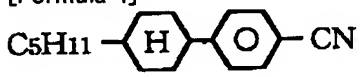

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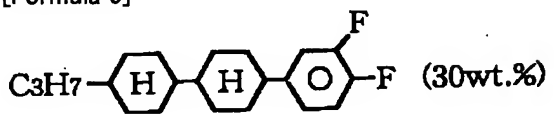

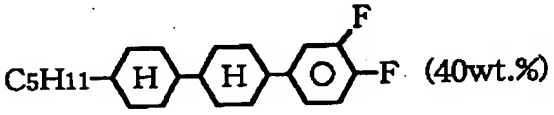

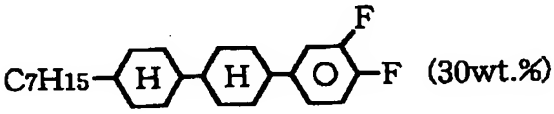

[0050] Although the liquid crystal ingredient of ** 1 was mentioned above, the liquid crystal ingredient of 5CB(s) (4-cyano-4'-n-pentyl biphenyl) and ** 2 5OCBs (4-cyano-4'-n-pentyloxy biphenyl) and the liquid crystal ingredient of ** 3 The equivalent mixture of 3OCBs (4-cyano-4'-n-propyloxy biphenyl), 5OCBs, and 7OCBs (4-cyano-4'-n-heptyloxy biphenyl), and the liquid crystal ingredient of ** 4 The liquid crystal ingredient of PCH5 (transformer-4-heptyl -(4-cyanophenyl)- cyclohexane) and ** 5 Mixture of 3HPFF(s), 5HPFF(s), and 7HPFF(s) (with 1 and 2-difluoro-4-[transformer-4-(transformer-4-n-propyl cyclohexyl) cyclohexyl] benzene) 1 and 2-difluoro-4-[transformer-4-(transformer-4-n-pentyl cyclohexyl) cyclohexyl] benzene, It is the mixture which consists of 1 and 2-difluoro-4-[transformer-4-(transformer-4-n-heptylcyclohexyl) cyclohexyl] benzene. Although a comparatively low electrical potential difference (less than [100V]) describes in detail to the top in which light modulation is possible, and the back even if it is the case where which of the ingredient shown in ** 1 —izing 5 is used when an electrode spacing is set to 50 micrometers so that clearly also from Table 1, it essentially has the high-speed response characteristic, and has the engine performance which is excellent as a display.

[0051] The technical thought of this invention The substrate of a pair at least with transparent one side, (Gestalt 1 of operation) The medium containing the polar molecule pinched between the substrates of said pair, and the polarizing plate arranged in one [at least] outside among the substrates of said pair, The display excellent in the high-speed response characteristic is offered by considering as

the display equipped with the phase transition means for making said medium into an isotropic phase condition, and the electric-field impression means for impressing electric field to said medium. Specifically, it is as follows.
[0052] The top view and drawing 3 which show the electrode configuration and rubbing bearing in the display which the fragmentary sectional view and drawing 2 which the display which impresses electric field in parallel with the substrate side which drawing 1 requires for the gestalt 1 of operation of this invention simplified similarly apply to the gestalt 1 of operation are the fragmentary sectional view showing the condition at the time of electric-field un-impressing the display similarly applied to the gestalt 1 of operation.
[0053] The glass substrate 21 with which the polyimide film 22 (orientation film SE[by Nissan Chemical Industries, Ltd.]- 7792) as a dielectric thin film was produced as this display 20 was shown in drawing 1 , While the glass substrate 28 with which it has the tandem-type electrode which consists of a pixel electrode 26 and a counterelectrode 27, and the polyimide film 25 was produced by the front face is stuck through the glass fiber spacer 24 and set to gap 50micrometer It is the display of the horizontal electric-field method with which the closure of the liquid crystal ingredient 23 which is a medium containing a polar molecule was carried out, and it was constituted between said glass substrates 21.28.
[0054] Said liquid crystal ingredient 23 becomes Table 1 mentioned above from the liquid crystal ingredient [3] of a publication. moreover, it has the heater 34 which is a phase transition means for making the phase transition of said liquid crystal ingredient [3] change into an isotropic phase condition to the display 20 of this invention, and the liquid crystal ingredient [3] is made into the isotropic phase condition by heating with 65.5 degrees C concrete — at this heater 34.
[0055] In addition, although it considers as the isotropic phase condition macroscopically by making said liquid crystal ingredient [3] into the temperature around 65.5 degrees C although stated in detail later, a molecule ensemble can be made to form in polar molecule 23a— in a liquid crystal ingredient [3] microscopically. In addition, this molecule ensemble is called a "cluster" and orientation of polar molecule 23a— is carried out in the fixed direction within cluster 23c.
[0056] Moreover, the thin film transistor (TFT) as the Kushigata electrode which consists of a pixel electrode 26 which is an electric-field impression means, and a counterelectrode 27, metal wiring (a picture signal line, scan signal line), and a pixel switching element etc. is formed in the medial surface of said glass substrate 28. In addition, metal wiring, TFT, etc. are omitted in drawing 1 . Moreover, the line breadth of said pixel electrode 26 and said counterelectrode 27 is setting the electrode spacing of 10 micrometers, and said pixel electrode and said counterelectrode to 10 micrometers.
[0057] Moreover, in said direction 31-32 of rubbing, while the lateral surface of said substrate 21-28 and mutual absorption shaft orientations cross at right angles, the polarizing plate 29-30 is arranged so that the include angle of 45 degrees may be accomplished. In addition, what arranges said polarizing plate 29-30 so that mutual absorption shaft orientations may become parallel is possible.
[0058] Moreover, as shown in drawing 2 , about a substrate 28, it goes rightward [space top / 32], goes leftward [space top / 31] about a substrate 21, and orientation processing of said polyimide film 22-25 is carried out.
[0059] Thus, by carrying out orientation processing of the polyimide film 22-25, the orientation of cluster 23c— located in this 22-polyimide film 25 front face can be made to carry out in the fixed direction, and the thing of the cluster 23c— concerned for which a path is increased further becomes possible. A Kerr constant can be increased and this enables it to reduce the applied voltage impressed to a display.
[0060] Moreover, as shown in drawing 2 , the pixel electrode 26 and counterelectrode 27 which constitute the Kushigata electrode are formed in the character type configuration of plane view "**", and its angle-of-visibility property of a display improves.
[0061] Moreover, the back light 33 is arranged at the tooth-back side (drawing 1 under) of said indicating equipment 20. Moreover, although not illustrated, what constitutes the display 20 in which color display is possible is possible by forming a color filter on said substrate 21.
[0062] Thus, in the produced display 20, although the liquid crystal ingredient [3] is held at 65.5 degrees C at the heater 34 as mentioned above, the meaning of the temperature concerned is explained below here using drawing 5 . Drawing 5 is a graph which shows temperature and the relation of a Kerr constant.
[0063] Although said liquid crystal ingredient [3] consists of a polar molecule from which a condition changes with temperature like a nematic phase or an isotropic phase, when it holds to the temperature (nematic isotropic phase transition temperature) around 65.5 degrees C (TM in drawing 5), the molecule ensemble called a "cluster" is generated. Although said cluster is presenting the isotropic phase condition macroscopically, the molecule is carrying out orientation of it in the fixed direction within the cluster microscopically.
[0064] And if whenever [stoving temperature / of said liquid crystal ingredient [3]] is raised from 65.5 degrees C which is nematic isotropic phase transition temperature, said cluster will become scatteringly (whenever [order] becomes small), consequently a Kerr constant will fall. If a Kerr constant falls as mentioned above, applied voltage must be increased and it is inconvenient practically.
[0065] However, what should be observed can increase a Kerr constant here by carrying out orientation processing of the dielectric thin film (polyimide film 22-25), as shown in drawing 5 .
[0066] When this carries out orientation processing of the polyimide film 22-25 in the predetermined direction, a polar molecule can carry out orientation in the orientation processing direction of the polyimide film 22-25 [near the substrate interface], whenever [order] can increase the path of increase and a cluster, and it is thought with increase of the path of a cluster that a Kerr constant is for increasing. Moreover, by increasing a Kerr constant, it becomes possible to reduce the applied voltage impressed to a display, and practical use can be presented now.
[0067] Next, the approach of the display 20 constituted in this way of operation is explained. Drawing 4 is a conceptual diagram showing the spin polarization of electron in the polar molecule at the time of electric-field un-impressing [of drawing 3], and electrical-potential-difference impression.
[0068] Beforehand, a liquid crystal ingredient [3] is heated at 65.5 degrees C at a heater 34. As shown in drawing 4 (a), when the electrical potential difference is not being impressed between the pixel electrode 26 and a counterelectrode 27, polar molecule 23a in a liquid crystal ingredient [3] is in an isotropic phase condition as the whole, though cluster 23c— is formed near polyimide film 22 and the 25 front faces.
[0069] In this condition, as shown in drawing 4 (b), when an electrical potential difference is impressed between the pixel electrode 26 and a counterelectrode 27 with drive switches, such as TFT, electric field occur in a substrate side in parallel, and 23d of electrons in polar molecule 23a inclines in the direction of electric field (a space top, right).
[0070] And the light from the back light 33 shown in drawing 1 turns into the linearly polarized light by passing a polarizing plate 30, by

passing through the inside of said liquid crystal layer 23, the linearly polarized light turns into elliptically polarized light, can pass a polarizing plate 29 now, turns into the linearly polarized light again, and outgoing radiation is carried out out of a display 20. In addition, half-wave voltage Vpi in that case was 40.0V.

[0071] Moreover, electric-field off->on (build up time) of the optical response time of said display 20 was 10 microseconds, and electric-field on->off (falling time amount) was 1 or less microsecond. In addition, the build up time of the response time of the liquid crystal display of the conventional TN mold is 15ms even in the response between monochrome binary, falling time amount is 20ms, and further, even if the response time between gradation at the time of a halftone display is 100ms - 200ms, and it compares it with the grand total and it impresses the high voltage to the liquid crystal display concerned, it cannot make a speed of response quick like the display 20 of this invention. Therefore, the display 20 of this invention has the outstanding property which can improve a speed of response by leaps and bounds as compared with the liquid crystal display of the conventional TN mold.

[0072] Next, the manufacture approach of said display 20 is explained.

[0073] First, the pixel electrode 26 and counterelectrode 27 which are a thin film transistor (not shown) and a tandem-type electrode were formed on the glass substrate 28.

[0074] Next, the spinner was used for said glass substrate 28 front face, and the polyimide film 22 (orientation film SE[by Nissan Chemical Industries, Ltd.]- 7792) was produced. Moreover, the spinner was used also for said glass substrate 21 front face, and the polyimide film 22 (orientation film SE[by Nissan Chemical Industries, Ltd.]- 7792) was produced.

[0075] Next, after performing rubbing processing in the direction which shows said glass substrate 21-28 to drawing 2 , lamination and a gap 50micrometer display were produced through the glass fiber spacer 24.

[0076] next, a law — according to the method, the liquid crystal ingredient [3] given in Table 1 was enclosed.

[0077] Next, while the lateral surface of said substrate 21-28 and mutual absorption shaft orientations crossed at right angles the polarizing plate 29-30, in said directions 31 and 32 of rubbing, it pasted together so that the include angle of 45 degrees might be accomplished, and the display 20 was produced.

[0078] (Gestalt 2 of operation) The fragmentary sectional view and drawing 7 which the display which impresses electric field at right angles to the substrate side which drawing 6 requires for the gestalt 2 of operation simplified are the top view showing the electrode configuration and rubbing bearing in the display similarly applied to the gestalt 2 of operation.

[0079] The glass substrate 42 which this display 40 has a transparent electrode 43, and applied the polyimide film 44 (polyimide orientation film coating JALSmade from JSR- 682) as a dielectric thin film as shown in drawing 6 , and was calcinated at 180 degrees C for 1 hour, While having a transparent electrode 48, and applying the polyimide film 47 to a front face, sticking the glass substrate 49 similarly calcinated at 180 degrees C for 1 hour through the glass fiber spacer 45 and being referred to as gap 50micrometer Between said glass substrates 42.49, the closure of the liquid crystal ingredient 46 is carried out, and it is constituted.

[0080] In addition, although the transparent electrode 48 is formed in the medial surface of said glass substrate 49, the thin film transistor (TFT) as metal wiring (a picture signal line, scan signal line) and a pixel switching element etc. is formed like the case of the gestalt 1 of operation.

[0081] Moreover, as shown in drawing 7 , about a glass substrate 49, it goes rightward [space top / 52], goes leftward [space top / 51] about a glass substrate 42, and orientation processing of the orientation processing direction of said orientation film 44-47 is carried out.

[0082] Moreover, the transparent electrode 43 as a counterelectrode is formed in the medial surface of a glass substrate 42, and the orientation film 44 which consists of polyimide is further formed on the transparent electrode 43. Moreover, a polarizing plate 41 is arranged at the lateral surface of said glass substrate 42, and further, while a polarizing plate 50 is arranged at the lateral surface of said glass substrate 49 and the absorption shaft orientations of said polarizing plate 41-50 intersect perpendicularly, it is pasted together and constituted in said direction 51-52 of rubbing, so that the include angle of 45 degrees may be accomplished. In addition, you may make it form a color filter like the case of the gestalt 1 of operation on a glass substrate 42.

[0083] Next, said liquid crystal ingredient 46 is explained.

[0084] Said liquid crystal ingredient 46 mixes the ethyl alcohol 0.1 weight section which is the non-liquid crystallinity matter in the mixture 100 weight section which becomes said table 1 from the liquid crystal ingredient [5] (** 5) of a publication. In addition, like the publication to Table 1, said liquid crystal ingredient [5] can lower phase transition temperature sharply by adding ethyl alcohol to this, although nematic phase-isotropic phase phase transition temperature is 113.0 degrees C.

[0085] That is, if the ethyl alcohol 0.1 weight section is mixed to the liquid crystal ingredient [5] 100 weight section, phase transition temperature can be lowered to 35.2 degrees C and the addition of ethyl alcohol will be increased like the gestalt 2 of this operation, the phase transition temperature of a liquid crystal ingredient can be lowered further. Thus, ethyl alcohol will have a function as a phase transition means for making a liquid crystal ingredient into an isotropic phase condition.

[0086] Moreover, said liquid crystal ingredient [5] is a liquid crystal ingredient of n mold, and in the gestalt 2 of this operation, since the electric-field impression direction is perpendicular to a substrate, the electron in a liquid crystal ingredient (polar molecule) will incline in the perpendicular direction to the electric-field impression direction.

[0087] And said display 40 was held at 35.2 degrees C at the heater 53 which is a phase transition means, and when half-wave voltage Vpi was measured, the value of 35.0V was acquired. Moreover, the build up time (electric-field off->on) of the optical response time was 6 microseconds, and falling time amount (electric-field on->off) was 1 or less microsecond. Therefore, the speed of response of the display 40 concerning the gestalt 2 of operation of this invention improves by leaps and bounds like the display 20 of the gestalt 1 of operation.

[0088] Furthermore, as mentioned above, even if nematic phase-isotropic phase phase transition temperature is an ingredient with high phase transition temperature like the liquid crystal ingredient [5] which is 113.0 degrees C, it becomes possible by adding ethyl alcohol etc. to lower phase transition temperature sharply.

[0089] Moreover, when ethyl alcohol was added into a liquid crystal ingredient, the falls of the Kerr constant of the liquid crystal ingredient concerned were few. In addition, although ethyl alcohol was used as an additive with the gestalt 2 of this operation, it is possible to reduce phase transition temperature also by using the compound which is the non-liquid crystallinity matter which has a cyano group, a nitro group, and a hydroxy group.

[0090] Thus, the display concerning the gestalt 2 of this operation can be excellent in responsibility like the display concerning the gestalt 1 of operation, and can reduce the phase transition temperature to the isotropic phase condition of a liquid crystal ingredient

sharply further by adding the ingredient which can lower phase transition temperature to this liquid crystal ingredient, using a liquid crystal ingredient as an ingredient which consists of a polar molecule.
[0091] (Gestalt 3 of operation) Drawing 8 is the fragmentary sectional view concerning the gestalt 3 of operation which the display simplified. Although the gestalt 1 of said operation and the gestalt 2 of operation showed the example which constituted the display of a transparency mold, it is not restricted to these, and as shown in the gestalt 3 of this operation, it can also consider as the display of a reflective mold.
[0092] Namely, the glass substrate 69 which has the electrode 68 which consists of reflective film, and applied the polyimide film 67 as a dielectric thin film, and was calcinated at 180 degrees C for 1 hour as the display 60 of a reflective mold was shown in drawing 8 , While the glass substrate 62 with which it has a transparent electrode 63, and the polyimide film 64 was produced by the front face is stuck through the glass fiber spacer 65 and set to gap 50micrometer, between said glass substrates 62.69, the closure of the liquid crystal ingredient 66 is carried out, and it is constituted.
[0093] Moreover, what uses for a way side the reflecting plate which forms the reflective film which used for example, metal aluminum as the principal component, or consists of metal aluminum etc. instead of a glass substrate 69 further outside said glass substrate 69 is possible.
[0094] (Gestalt 4 of operation) Drawing 9 is the fragmentary sectional view concerning the gestalt 4 of operation of this invention which the display simplified.
[0095] First, with reference to drawing 9 , the configuration of the display concerning the gestalt 4 of this operation is explained. While the display 20 concerning the gestalt 4 of this operation can be displayed by change of the orientation of a liquid crystal molecule, control of the electron distribution by electric field can be displayed also by use (namely, change of the spin polarization of electron in the liquid crystal molecule (polar molecule) of an isotropic phase condition).
[0096] That is, said display 20 is equipped with the thermo-sensor 74 grade connected to the 1st drive circuit 70 for displaying by change of the orientation of a liquid crystal molecule, the 2nd drive circuit 71 for displaying by the spin polarization of electron in the polar molecule of an isotropic phase condition, the switching circuit 72, the switch control circuit 73 that controls the change of the switching mode of this switching circuit 72, and this switch control circuit 73. Moreover, the heater 34 explained with the gestalt 1 of operation is connected to said switch control circuit 73.
[0097] Moreover, said 1st drive circuit 70 and said 2nd drive circuit 71 are connected to the pixel electrode 26 and counterelectrode 27 which constitute a display 20 through a switching circuit 72.
[0098] Subsequently, the drive approach of said display 20 is explained.
[0099] the case where it is made to display said indicating equipment 20 by change of the orientation of a liquid crystal molecule — said switch control circuit 73 — a switching circuit 72 — the 1st drive circuit 70 side — changing — this — it displays by impressing an electrical potential difference between said pixel electrodes 26 and said counterelectrodes 27 by the 1st drive circuit 70.
[0100] moreover — the case where it is made to display said indicating equipment 20 by the spin polarization of electron in a polar molecule — said switch control circuit 73 — a switching circuit 72 — the 2nd drive circuit 71 side — changing — this — it displays by impressing an electrical potential difference between said pixel electrodes 26 and said counterelectrodes 27 by the 2nd drive circuit 71.

[0101] Moreover, detect the temperature of said liquid crystal layer 23 with said thermo sensor 74, input the detected value into the switch control circuit 73, and if the detected value is beyond the temperature from which said liquid crystal layer 23 serves as an isotropic phase Display by impressing an electrical potential difference to said liquid crystal layer 23 by said 2nd drive circuit 71, and if the detected value is lower than the temperature from which said liquid crystal molecule serves as an isotropic phase conversely It seems that it can display by heating said liquid crystal layer 23 at the heater 34 connected to the switch control circuit 73, and impressing an electrical potential difference by said 2nd drive circuit 71 by making this liquid crystal layer 23 into an isotropic phase condition.
[0102] Thus, when using it as a good liquid crystal television of image quality, when a high-speed response is required, it can be displayed and it is excellent [indicating equipment / the indicating equipment 20 of the gestalt 4 of this operation is made to display by change of the orientation of a liquid crystal molecule, and / with change of the spin polarization of electron in the liquid crystal molecule (polar molecule) of an isotropic phase condition] in high-speed image analyses, such as a simulation, at convenience with animation display.
[0103] (Other matters)
(1) In the indicating equipment concerning the gestalt 1 of operation thru/or the gestalt 4 of operation, it is possible to use a plastic film substrate instead of a glass substrate.
[0104] (2) The display in which a high-speed response is possible can also be constituted by considering as the display equipped with the medium containing the polar molecule of a direction phase state — at least one side was pinched between the substrate of a transparent pair, and the substrate of said pair — the polarizing plate arranged in one [at least] outside among the substrates of said pair, and the electric-field impression means for impressing electric field to said medium. That is, in the gestalt 1 of operation thru/or the gestalt 4 of operation, although considered as the isotropic phase condition with the phase transition means for making the medium containing a polar molecule into an isotropic phase condition, it is also possible to use as others the medium which consists of a polar molecule of isotropic phase conditions, such as water. In addition, it is not necessary to use a phase transition means in that case.
[0105] (3) In the gestalt 1 of this operation thru/or the gestalt 4 of operation, although the polyimide film was used as a dielectric thin film, it is also possible for it not to be restricted to this and to use an organic thin film, polyvinyl alcohol, etc.
[0106] (4) In the gestalt 1 of this operation thru/or the gestalt 4 of operation, although the display of an active-matrix mold was explained, it can also consider as the display of a passive-matrix mold.
[0107]
[Effect of the Invention] as mentioned above, the thing which the display of this invention is a display using the Kerr effect, does not change transparency and cutoff of light by motion of a molecule as compared with the conventional liquid crystal display, and changes transparency and cutoff of light by the spin polarization of electron — it is — moreover, dozens — 100% of intensity modulation is possible by V or less low battery, and the practical value has a very high speed of response as a thin display which fitted the cine mode display quickly.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the fragmentary sectional view concerning the gestalt 1 of operation of this invention which the display which impresses electric field in parallel with a substrate side simplified.
[Drawing 2] It is the top view showing the electrode configuration and rubbing bearing in the indicating equipment similarly applied to the gestalt 1 of operation.
[Drawing 3] It is the fragmentary sectional view showing the condition at the time of electric-field un-impressing the display similarly applied to the gestalt 1 of operation.
[Drawing 4] It is a conceptual diagram showing the spin polarization of electron in the polar molecule at the time of electric-field un-impressing [of drawing 3], and electrical-potential-difference impression.
[Drawing 5] It is the graph which shows temperature and the relation of a Kerr constant.
[Drawing 6] It is the fragmentary sectional view concerning the gestalt 2 of operation of this invention which the display which impresses electric field at right angles to a substrate side simplified.
[Drawing 7] It is the top view showing the electrode configuration and rubbing bearing in the indicating equipment similarly applied to the gestalt 2 of operation.
[Drawing 8] It is the outline sectional view showing the configuration of the display of the reflective mold concerning the gestalt 3 of operation of this invention.
[Drawing 9] It is the outline sectional view showing the configuration of the display concerning the gestalt 4 of operation of this invention.
[Drawing 10] It is the schematic diagram showing the system of measurement of the electro-optical effect of the gestalt of operation of this invention.
[Description of Notations]
1 Opto Electronics Material
4-5 Electrode
6 Cel
7 Modulation Power Source
8 Polarizing Plate
9 Analyzer
10 Beam of Light
11 Detector
20 Display
21-28 Glass substrate
22-25 Polyimide film
23 Liquid Crystal Ingredient
23a Polar molecule
23c Cluster
24 Spacer
26 Pixel Electrode
27 Counterelectrode
29-30 Polarizing plate
31-32 The direction of rubbing
33 Back Light
34 Heater
40 Display
41-50 Polarizing plate
42-49 Glass substrate
43-48 Transparent electrode
44-47 Polyimide film
45 Spacer
46 Liquid Crystal Ingredient
51-52 The direction of rubbing
53 Heater

[Translation done.]

* NOTICES *

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damages caused by the use of this translation.

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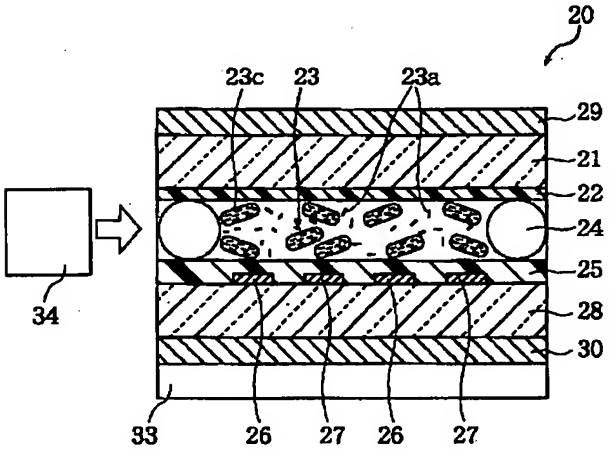
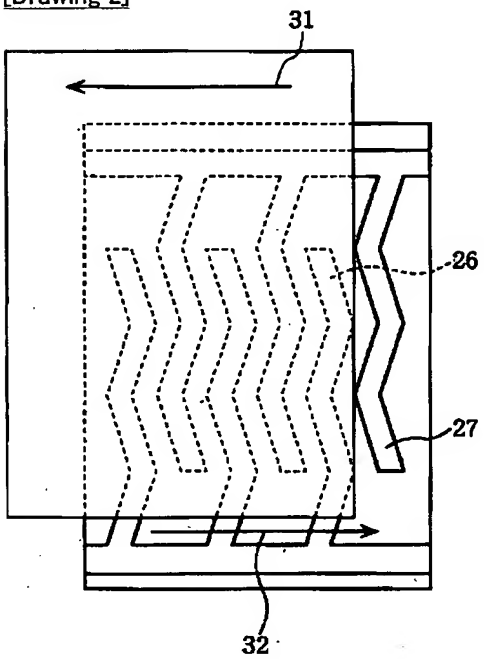
DRAWINGS

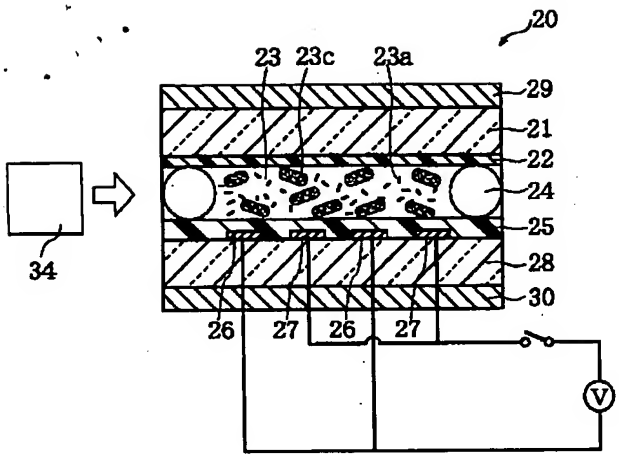
[Drawing 1]



[Drawing 2]

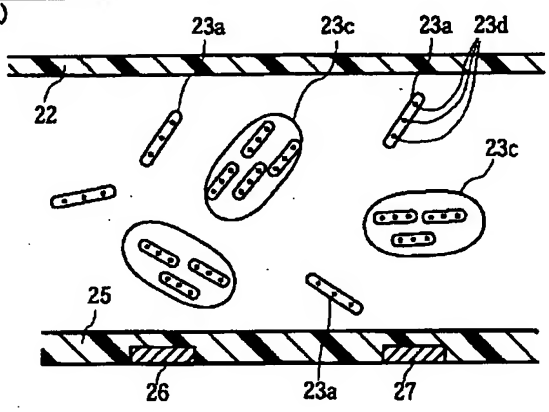


[Drawing 3]



[Drawing 4]

(a)



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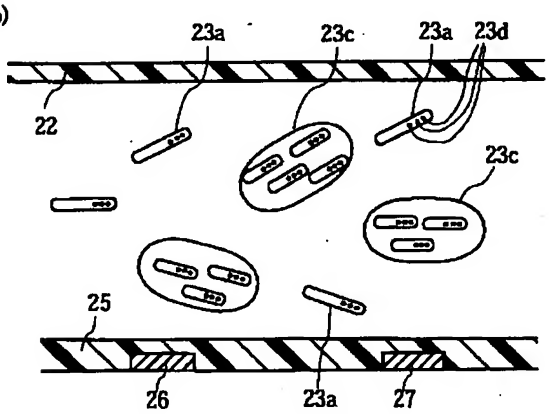
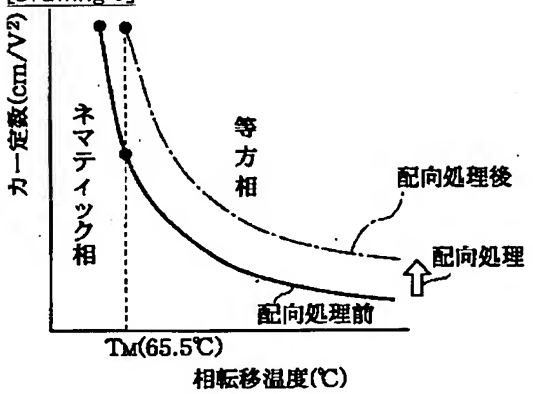
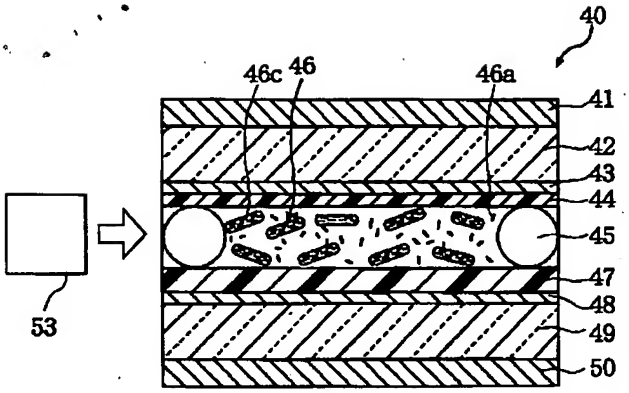


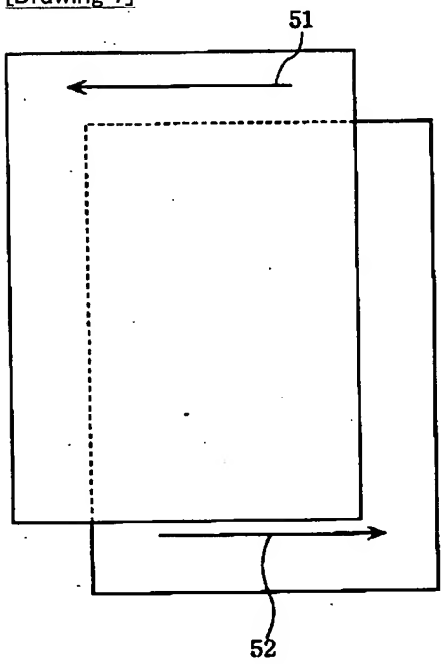
[Drawing 5]



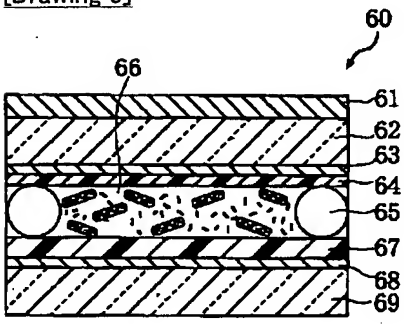
[Drawing 6]



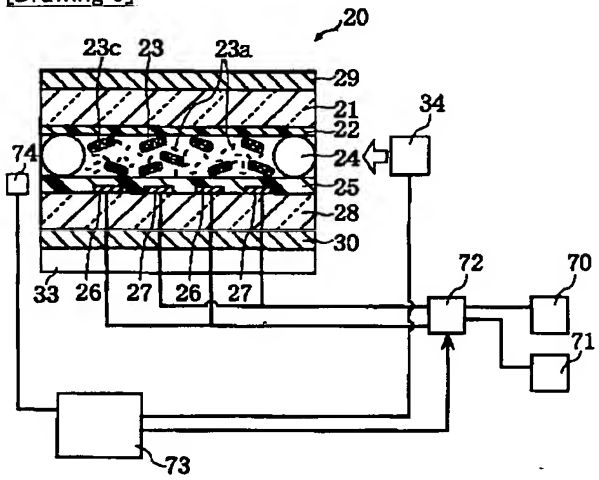
[Drawing 7]



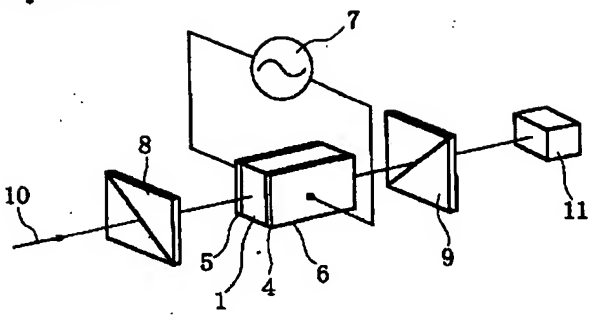
[Drawing 8]



[Drawing 9]



[Drawing 10]



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